

# METHOD AND APPARATUS FOR BAG-TO-SET, BUFFERING REMEMBERED SET

## ABSTRACT OF THE DISCLOSURE

The present invention provides a method and apparatus for bag-to-set, buffering remembered set. In accordance with the present invention, a remembered set is initially maintained as a bag. Then, at evenly spaced intervals over the execution of the computer program (or at other intervals), the bag is transformed into a set. By transforming the bag to a set at various intervals in the program's execution, the user observable pause associated with write barrier code becomes minimal or non-existent. In addition, when a process uses the remembered set, a garbage collector or persistent checkpoint, for instance, the remembered set can be scanned more efficiently. In one embodiment, the addresses of all updated objects are pushed to a thread local store buffer, which may be in the form of a stack data structure. When the thread local stack overflows, the local stack is flushed to a global store buffer. The threads comprise concurrent paths of execution within a single computer program. Thus, a plurality of threads that make up a single executing process may have their local stacks flushed to the global store buffer in the manner described by the invention. When flushing the local store buffer to the global store buffer, one embodiment of the invention uses a duplicate prevention scheme. In the duplicate prevention embodiment, the global store buffer may contain free space after the local store buffer is flushed. In this case, the local store buffer is re-allocated an amount of space to match the global store buffer's contiguous free space. This re-allocation continues until the local store buffer's space allocation falls below a pre-determined and variable minimum threshold. When the minimum threshold is reached the local store buffer's allocation is reset to the original allocation size and write barriers continue to be observed.